

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

ORI

(NASA-CR-156713) ALTERNATIVE MANAGEMENT AND
FUNDING OPTIONS FOR AERONAUTICS PROGRAMS:

N78-20989

TASK 1 (Operations Research, Inc.) 45 p HC
A03/MF A01 CSCI 05A

Unclas
12128

G3/81

OPERATIONS RESEARCH, Inc.

SILVER SPRING, MARYLAND

**ALTERNATIVE MANAGEMENT AND FUNDING
OPTIONS FOR AERONAUTICS PROGRAMS**

(TASK 1)

5 MARCH 1975

Contract No. NAS 5-24033, Mod. 22

NASA/GSFC

TABLE OF CONTENTS

	Page
INTRODUCTION	1
PURPOSE	1
OVERALL PERSPECTIVE	1
CRITERIA FOR GOVERNMENT'S AND NASA'S ROLE IN SUPPORTING AVIATION RESEARCH AND TECHNOLOGY . . .	2
RECOMMENDATIONS	8
APPENDIX A — WHY GOVERNMENT AND NASA FOR AVIATION RESEARCH AND TECHNOLOGY	A1-20
APPENDIX B — A CHRONOLOGICAL RECORD OF HISTORICAL EVENTS (WITH A BRIEF CITATION TO IDENTIFY THE DOCUMENT). PART A	B1-10

ALTERNATIVE MANAGEMENT AND FUNDING OPTIONS FOR AERONAUTICS PROGRAMS

INTRODUCTION

1. This is a final report for NASA/OAST dealing with alternative management and funding options for aeronautics programs. It is provided in response to Task I of Contract No. NAS 5-24033, Mod. 22.

PURPOSE

2. The purpose of this report is to set forth the advantages and disadvantages of alternative methods of both managing and funding NASA's current and projected aeronautics programs, and ultimately providing improved economic analyses methods and information for use in the evaluation and selection of OAST Research and Technology (R&T) Programs.

OVERALL PERSPECTIVE

3. In an effort to place the aeronautical industry in the proper perspective and to assess its value to the Nation, A Bibliography of the Federal Government's and NASA's Role in Aeronautical Research, Technology and Development was prepared and submitted in December as part of Task I. This study was made in response to a request for basic historical information relating to the Government's and NASA's role in aeronautical research, technology, and development, starting with the earliest Board's initiation of NACA, and other Governmental efforts. It is a compilation of studies, hearings before Congressional committees, reports of Presidential commissions, legislative enactments, and items of special interest in the form of a chronological bibliography and is intended to serve as a working document. The study contains four volumes as follows:

Part A -- A Chronological Record of historical events (with a brief citation to identify the document).

Part B -- Summary of major developments and studies affecting Aeronautical Research, Technology, and Development within the Government with particular emphasis on the role of NACA and NASA in this area.

Part C -- Major legislative actions in support of Aeronautical Research, Technology, and Development.

Part D -- Documented citations with excerpts providing background for referenced material and legislation. This section is contained in separate volumes for the convenience of the reader, as follows:

Volume I: 1890's - 1966

Volume II: 1967 - 1971

Volume III: 1972 - 1974.

Part A, the chronological record of historical events, is attached as Appendix B, for use as a backdrop for further investigation and consideration toward policy planning for aeronautical research and development.

CRITERIA FOR GOVERNMENT'S AND NASA'S ROLE IN SUPPORTING AVIATION RESEARCH AND TECHNOLOGY

4. The factors which are of the greatest importance for developing policy in the area of aeronautical research and development follow.

Aviation is big business. The industry is the third largest U. S. industrial employer with over 700,000 employees. Its use is growing at phenomenal rates. The U.S. is the world leader today. This success is due to large research and development efforts of the military, NASA and FAA. As a result, 83 percent of the free world aircraft are U.S. built. The industry has a major role in the export trade and provides a significant element of GNP.

To continue this in the future requires continued significant expenditures for research. Military funded research and development (R&D) has supported civil aviation to a considerable extent either directly as in the case of engines, or indirectly from military oriented R&D programs that provided technology usable by civil designers. A number of specific future civil needs, however, will not be satisfied by military R&D. Additional specific and concentrated efforts in research will be required by the civil sector. These include noise and air pollution research, better low-speed flight characteristics, redirection of wake turbulence, better cross wind handling capabilities, anti-collision systems, fire hazard reductions, improved ATC, and all-weather operations capacity, economies, safety and environment. In addition, research and technology will be at lower program levels with basic military research for aviation decreasing as fewer aircraft programs are initiated and the present new aircraft programs move into the prototype and production status. Also,

financial problems are facing some of the aircraft manufacturers reducing their funding capability for research and technology. Consequently the intensive research effort will not come from industry but must come from NASA and DOT/FAA. This is an investment for the future.

Between now and 1990 an estimated \$100 billion will be expended on new equipment. Competition from Europe and Japan are aiming to capture a significant portion of this market. To offset these efforts, the U. S. must continue to maintain its technical superiority. This requires an aggressive commercial transport research and technology program sponsored by the U. S. Government. NASA has the technical team and facilities to carry on this intensive effort.

The aviation industry is a major force in the U. S. It employs over 700,000 employees in manufacturing and the airlines. Its sales are over \$25 billion annually. It is the contributor of a positive trade balance, with over \$3.5 billion in hardware sales in 1973. A phenomenal growth in domestic transportation is projected over the next 30 years. By 1980 an average of over 1 million passengers daily are projected. Projections of sales to replace existing equipment and to meet their expanding workload projections are estimated to be over \$100 billion between now and 1990. The U. S. is the world leader in aviation.

This leadership is due to the support that the Federal Government has provided over the past 50 years. The national goals and mandates for aviation are directed to preserving the role of the U. S. as leader in aeronautical science and technology. Congress has directed that aeronautical activities be the responsibility of and be directed by civilian agencies. The role of the Federal Government has been in the sponsorship of substantial research and development, regulation of safety and aircraft operations, operation of airways, and in the control of economics. In the civil aviation area for example, over \$400 annually is being spent by NASA and DOT for R&T.

Federal support has resulted in the development of a large aviation industry, both in manufacturing and in air transportation.

Most manufacturing companies have been engaged in military procurement, with civil aviation benefitting from the military effort by a transfer of technology. As military procurement emphasis shifts from the long haul transportation aspect, industry will be faced with financing the research on future long haul aircraft. Long term investment will be required, in some cases several times a net worth of the manufacturer, with no appreciable financial return for a period of 5-10 years after program commencement. Such financial problems as cash flow are already being experienced by some manufacturers. In addition foreign competition is developing under a heavily subsidized national basis. Europeans for example, are striving for a deep penetration of the world market, hoping to capture 20-25 percent of aircraft sales by 1980.

The air transportation industry has traditionally been heavily government controlled and regulated. An oligopolistic structure exists. The area of government participation has been in safety, reliability of service and economics.

Superiority of the U. S. aircraft industry has been maintained by a strong research and technology effort, major emphasis in the design and production phases on performances, effectiveness, cost, operating efficiency, reliability, and safety. Government support has assisted in financing, including credits for foreign sales. An active marketing and service support effort have been integral elements of the aviation industry.

Research and technology is a basic major building block in the overall well-being of the aviation industry. This is the area of emphasis as we examine its importance to the future. Government sponsorship has provided the impetus for most of the technological advances made by U. S. aviation. Generally the military has been the first to use the significant technological advances, building a foundation of operational experience that led to acceptance and use in civil aircraft programs several years later. Continued U. S. leadership in aviation requires major research effort today in areas such as noise abatement, pollution control, congestion, energy savings, short haul air transportation, and long haul air transportation.

Research and technology is pursued by government, industry, and universities. In government, NASA performs basic research and technology, establishes proof of the concept, disseminates findings in research and technology, and supports other agencies and industry with its unique national facilities. DOT/FAA performs research, technology, and development effort on air traffic control, runway and airports, navigation aids, communication, and environment.

Military research has financed significant efforts in research, technology and development, especially in applied research and prototyping for specific aircraft systems. Industry effort is principally sponsored by government contracts for research and technology. Industry has financed civil vehicle prototype development and some applied technology. Universities, operating generally under government contracts, are engaged in basic research and technology.

This research and technology effort is based on the legislative mandates of the National Aeronautics and Space Act of 1958 and objectives outlined in Presidentive Aeronautics and Space Reports. It is recognized that aeronautics research and technology are critical to the health of aviation. Government should continue to provide the reservoir of technology and provide financial backing.

The present role of government extends to management, establishing priorities of effort, and financing of research and technology. There are alternative approaches which need to be explored to determine the pros and cons. Management and control could be exercised by a quasi-Federal agency, a COMSAT-type organization, university sponsorship, or by industry. The real

question is public versus private management. In addition, there is a question of whether present financing by the government should continue, or whether the financing should become an industry responsibility, recoupments or user charges applied to the benefits given to industry or agency users, or a mixture, including joint funding of research and facilities. NASA has been operating under some jointly funded aircraft development programs and joint use of facilities. User charges for wind tunnel tests are under review.

The criteria for evaluating alternative approaches includes an examination of the nature of the product to be provided, responsiveness to changing needs, efficiency in terms of costs, ability to provide leadership, and to provide impartial and independent evaluation of approaches, and to provide technological inputs for regulating functions.

The key question of course is can industry take on the management and financing role and meet the criteria and characteristics considered essential for a viable research and technology program. Industry has performed research and development. It has the technical capability. Industry has performed some research and development with its own funding, but primarily in applied and prototype areas, directed toward specific aircraft systems. Major financing of research and technology has been by government.

The financing aspect needs careful review since the profit incentive necessitates a fast return in investment, compared to a 7-15 year lag in some major research projects for payback. Today's cash flow problems probably necessitate application to other purposes. The profit necessity discourages "Public Good" research and technology efforts. There is also a high cost of acquisition and operation of research and technology facilities.

The ability to disseminate findings of research and technology may also be impaired due to proprietary considerations. There are also some anti-trust problems if a consortium approach were applied. The consortium may be necessary to spread the risk, since large investments will be required as the level of technological sophistication increases.

The government role in managing and financing civil aeronautical research and technology has been successful. The government has met the test of responsiveness, the ability to undertake programs with great risk, providing financing, meeting foreign competition, exercising a coordinated research and technology effort on a long range planning basis, disseminating findings, providing independent evaluations, undertaking projects for "public good" which could result in government cost reductions, and utilizing the excellent facilities already in existence.

National crises require quick response and the ability to draw on the government base of scientific and engineering talent. This occurred during the recent energy crisis. The nature of many research and technology activities involve uncertainty as to outcome and success. Only the government can afford to take such risks, involving large negative cash flows for long lead times. Support by foreign governments of competitive aeronautical research and technology introduces an additional risk for U.S. firms, with the potential of reducing the market. Government, since it provides the necessary financial support, can assure a coordinated research and technology effort geared toward the long term national goals and objectives and avoiding overlapping and duplication. Government can properly discriminate results in a broad and nondiscriminatory manner. Government expertise provides an evaluation of competitive proposals and accurate validation of industry products and a role as technical broker between industry and the regulator. Government can undertake projects which will benefit government or industry as a whole and in many cases reduce costs, but for which there is no private incentive to engage in research and technology effort. Costs have already been sunk in establishing excellent government aeronautical facilities, many of which are unique. These are manned with highly competent personnel.

Within the government, NASA provides the major level of effort in civil aviation research and technology. This applies to environmental protection, short and long haul air transportation, aviation safety and air transportation system requirements and technology base. There has been considerable precedent, legislative and operational experience in performing these tasks. It has the ability to maintain independent non-advocacy position. NASA can benefit from commonality of the research base with space, including the relationship between aircraft and shuttle. NASA is the focal point for dissemination of aeronautical data. NASA has established excellent relationships with and an understanding of industry and other government agencies.

In summary, industry does not have the financial capability to assume Research and Technology responsibility due to (1) the large investment required, which may be several times greater than in net worth of manufacturer, (2) large negative cash flows, (3) risk with uncertainty of outcome and success in marketing, and (4) profit necessity. Industry also does not have the (1) responsiveness, (2) ability to disseminate findings on an impartial basis, (3) ability to evaluate proposals and serve as technical broker between industry and regulator, and (4) capability to establish a coordinated and balanced aeronautical Research and Technology program.

Government must thus continue to assume responsibility for management, control and funding. Some modifications in funding are possible with

greater use of jointly funded Research and Technology projects, utilization of user charges, and increased cost sharing with industry. Government can (1) provide responsiveness to crisis, (2) undertake programs with great risk, (3) provide financing, (4) meet foreign competition, (5) exercise a coordinated research and technology effort, (6) disseminate findings impartially, (7) provide independent evaluation, (8) undertake projects for "public good", and (9) maximize use of facilities and the strong scientific team already in existence.

NASA should continue to manage, control and finance Research and Technology for civil aviation, thus continuing the major role it has today. The size and scope of NASA's responsibilities may well increase as divergent design objectives between military and civil use occur. Requirements in Research and Technology for civil aviation may well increase. Also as program emphasis changes in the military area, program needs for civil aviation research and technology may increase to assure maintenance of U.S. superiority in civil aviation.

Any major change in management approach affecting financing and timing will have a massive effect on future civil aviation. A shift in funding responsibilities can bring great economic burdens on air transportation. There is no certainty that Research and Technology, as now planned, will be provided, which could result in the loss of U.S. leadership in aviation in the 1980's. Thus any change in management of funding approach should be the subject of intensive study before implementation.

Appendix A is attached as an outline providing the logic of the arguments supporting the foregoing issues in largely qualitative form. In appropriate cases, this is further supported by specific quantitative information.

RECOMMENDATIONS

Alternative Management and Funding Options for Aeronautics Programs

5. The NASA Aeronautical Research and Technology (R&T) program is aimed at providing the technological base to maintain U.S. superiority in civil and military aviation. The NASA program provides research, advanced technology, and experimental programs to remove growth restraints to civil aviation, provides direct support for future military systems, and undertakes fundamental research for the long term development of advanced aircraft. These efforts must be undertaken on a balanced basis, recognizing resource limitations, the speed with which aviation problems must be solved, and the priority with which the near-term problems and the long range problems should be solved. A number of alternative approaches are possible and these must be examined in terms of constraints and agency objectives.

The development of the aeronautical research and technology program must be supported by exhibits and analyses that facilitate weighing the gains and costs of alternative program sizes. Judgments or measurements of gains are important, in fact as important as measures of cost. The potential gains to be realized assume that certain breakthroughs or developments can be achieved. On the other hand, uncertainties must be recognized since research and technology often result in unpredicted payoffs. Cost/benefit analysis can be developed for appraising program productivity. The traditional industrial and administrative productivity, however, have limited application in the R&T area. Measures of productivity or effectiveness of research and technology can be based on the benefits estimated to be achieved. For example, in materials research, the objective of increasing the operating temperature capability of turbine materials, with resultant higher specific thrust, lower specific fuel consumption, greater reliability and a lower direct operating cost could increase the return on investment by as much as nine percent, according to NASA program staff. Increased usage of composite materials now in research could offer potential improvements in weight of 30 percent for large transports, estimated to be equivalent to a 20 percent decrease in operating costs of the aircraft. Improved knowledge of fatigue and fractures can reduce related maintenance cost to U.S. airlines of over \$75 million per year, plus increasing safety. This provides a measure of the potential benefits and a means of assessing priorities.

Another measure is to examine specific technological advances made in U.S. aviation. Of the 51 major technological advances made, Government research, technology and development (both military and civilian) contributed to over 45 of the advances. Private industry funded only six.

Another technique is to measure the overall increase in cost effectiveness. Benefits are viewed as products of the total system operating in a complex environment and making use of the capabilities provided by R&T.

Under this approach, overall improvements are considered. Operating costs, for example direct operating costs of aircraft since World War II, have been reduced threefold. Accident rates have decreased by a factor of five. A favorable balance of trade has been a direct benefit from civil aviation. Civil aviation has grown until it contributes over \$10 billion annually to the GNP. These favorable trends indicate the importance of Government support of research and technology. It should be noted that there is a significant time lag between development and acceptance ranging from 5 to 15 years, depending on the nature of the event.

Another approach in the evaluation of R&T is the concept of peers. Technically, coequal workers operating in the same disciplines judge the quality of the work conducted.

Quantification of performance, using such approaches as measuring the number of reports published, frequency of citations by others, patents, or the number of pages published in scientific journals—these measures can easily become self-defeating. The pressure to publish becomes paramount and quality suffers.

Priorities can be established as they relate to such major program areas as noise abatement; fuel conservation; emissions; alternative energy sources; research on airframe design, structures, and materials; wake turbulence; aircraft operational efficiency and safety; research on flight control avionics; human factors; aircraft fire technology; general aviation; and joint efforts with the military and other Federal agencies. Several program levels for each major area of research may be developed to provide management with meaningful program options. A balance between research areas is essential to assure that resources are used to meet the time-phased needs. There is no need for undertaking concurrent research effort, where one project can be accomplished in a shorter time frame, and both are essential to the completion of the total system effort. The shorter time period project can be deferred until its phasing is in line with the longer term project.

The elements of analysis to be applied to the major programs and projects should include the objectives, alternatives, resources required, models, and criteria. Choice of the objective is fundamental—what are the prime purposes of the NASA Aeronautics Research and Technology effort? What are the alternatives to attaining that objective? What are the costs of the alternatives? To predict the consequences of alternatives, models in the form of mathematical models or simple sets of relationships are established. Criteria is used to test which alternative should be chosen. Criteria are tests of preference. Ideally the course of action chosen should maximize the attainment of the objective in terms of resources utilized, timing, or satisfaction. Problems of choice can be divided into component pieces, i.e., suboptimization. Both gains and costs appear in the criteria.

Constraints of either gain or cost can be applied, seeking the way to get the most for a given cost, or to achieve a specified objective at least cost. Suboptimization—the breaking of the program into smaller chunks—permits the models used in estimating outcomes to be less aggregative and more accurate in the forecasts. It also permits better hedging against uncertainty by breaking the big problems into more manageable smaller pieces.

Cost/benefit analysis can be applied to NASA R&T. It permits a judgment as to whether the investment in research is productive. It provides a means of justifying budgets and establishing a measure of priority. The estimate of benefits will, of course, take time to validate. Historical efforts can be assessed in terms of benefits and past performance applied to the current R&T and its future estimated benefits. For management purposes, performance of the R&T can be assessed by using the scientists peers, both Government and industry. This approach has also been applied on a broader basis to establish an appraisal of a laboratory.

The R&T effort of NASA should thus stand up under the close scrutiny of cost/benefit analysis, the establishment of priorities for the use of the \$175 million in line with NASA agency objectives, the balanced program in terms of human technological capability, and periodically be subject to a peer review.

APPENDIX A

WHY GOVERNMENT AND NASA FOR AVIATION RESEARCH AND TECHNOLOGY

WHY GOVERNMENT AND NASA FOR AVIATION RESEARCH AND TECHNOLOGY

1. Importance of aviation
2. National goals and mandates for aviation
3. Nature of aviation industry in United States
4. Important elements of aviation industry
5. Importance of research and technology and key definitions
6. Present roles of government, industry and universities in research and technology
7. Government objectives in aeronautical research and technology
8. Questions relating to government role in research and technology--alternative approaches
9. Criteria for evaluating alternatives
10. Industry role
11. Government role
12. NASA role
13. Summary

IMPORTANCE OF AVIATION

- | | | | | | |
|--|-----|-------|-------|-------|--------|
| • National Asset | | | | | |
| - Third largest employer among manufacturers | 1/ | | | | |
| - Major producer of foreign exchange | 2/ | | | | |
| - Major producer of civil aviation products exported | 3/ | | | | |
| - Over one-third of total value of U.S. civil aviation products exported | 4/ | | | | |
| - Civil aircraft industry one of few with positive net trade balance. | | | | | |
| • Inventory-National Economy | | | | | |
| - \$13 billion sales from hardware | 5/ | | | | |
| - \$3.5 billion export sales - hardware | 7/ | | | | |
| - 700,000 jobs | 8/ | | | | |
| • Public Service-Transportation | | | | | |
| (Moderate GNP Growth) | | | | | |
| - Domestic | | | | | |
| - Passenger miles (billions) | | 104 | 126.3 | 274 | 591 |
| - Passengers (millions) | | 153 | 183.3 | 356 | 694 |
| - Air freight/express revenue tons (thousands) | | 2,216 | 2,453 | 8,064 | 30,324 |
| - Mail - revenue tons (thousands) | | 714 | 657 | 2,052 | 3,573 |
| - International | | | | | |
| - Air cargo revenue tons (thousands) | | 2,053 | 2,427 | 4,555 | 18,921 |
| - Aviation accounts for three times the revenue passenger miles of all other public modes (rail, bus and water) combined | 15/ | | | | |

- 78 percent of all U.S. inter-city passenger miles provided by commercial airlines (1973)^{16/}
- 95 percent of all U.S. intercontinental passenger miles are by air (1973).^{16/}
- National Security
 - Superior weapon systems for strategic and tactical missions continue to be produced for U.S. and our allies
 - Military requirements require continued procurement of military aircraft. For example, FY 1975 procures over 300 military aircraft, including F-15's, F-14's, E-3A's, A-10's, budget of over \$5 billion for procurement and about \$2 billion for research and development programs
 - Aircraft industry important element in mobilization planning.
- Additional Illustrations of Importance of Aviation as a National Resource and Asset
 - 83 percent of free-world commercial aircraft are U.S. manufactures^{17/}
 - 86 percent of turbojets on order are of American manufacture^{17/}
 - Civil aviation contribution to GNP has grown two or three times faster than economy as a whole^{18/}
 - Commercial aviation is big business. Cumulative sales of aircraft and power-plants since 1950 total over \$40 billion. Between now and 1990, over \$100 billion will be expended on new equipment.^{14/}

2. NATIONAL GOALS AND MANDATES FOR AVIATION

• National goals—National Aeronautics and Space Act of 1958 and Federal Aviation Act of 1958

- General welfare and security of United States requires that adequate provisions be made for aeronautical activities.
- Congress declares these aeronautical activities shall be the responsibility of and directed by civilian agency.
- Objective - Preservation of role of U.S. as leader in aeronautical science and technology
- Disseminate information on findings and results on most direct and practicable basis
- Undertake developmental work and service testing of improved aircraft, engines, propellers and appliances
- Provide for efficient navigation and traffic control of all civil aviation.
- Encourage and develop air transportation systems, properly adjusted to present and future needs of foreign and domestic commerce of U.S. Postal Service and national defense.
- Promote safety and development of civil aeronautics
- Control use of U.S. airspace and regulate both civil and military operations.
- Develop and operate common system of air traffic control and navigation for both military and civil aircraft. Promote adequate, economical, and efficient service by air carriers at reasonable charges, without unjust discriminations, undue preferences or advantages, or unfair or destructive competitive practices.

• Policies of Federal Government have supported Civil Aviation over the past 50 years.

- Major role of Federal Government in-

- Regulation of safety and aircraft operations
- Operation of airways
- Control of economics - rates, routes, and subsidies
- Sponsorship of research and development
- Commitment of substantial funds

- In Civil Aviation Research and Technology area for NASA and DOT, for example, the following estimated program levels: (in millions of dollars) 20

	FY72	FY73	FY74	FY75	FY76	FY77	FY78
NASA	\$216	\$255	\$276	\$294	\$304	\$295	\$285
DOT	<u>138</u>	<u>126</u>	<u>133</u>	<u>125</u>	<u>122</u>	<u>120</u>	<u>120</u>
	\$354	\$381	\$409	\$419	\$426	\$415	\$405

• Civil aviation should provide

- Transportation link between U.S. and all of major economic regions of the world
- Logistical support to defense establishment
- Developmental assistance to friendly nations
- Safety to passengers and security of cargo at terminals and during flight
- Consumer with suitable choice of service and costs
- Economic progress by encouraging and supporting development of new economic growth centers
- Conservation and development of national resources by increasing efficiency of vehicles, reducing pollution, balancing development of aviation with conservation and preservation of physical environment, and providing facilities consistent with land use policies.

3. NATURE OF AVIATION INDUSTRY IN UNITED STATES

● Manufacturing—Civil Aviation

- Composition of industry - 9 Air Frame manufacturers, 5 Engine manufacturers, 8 Avionics manufacturers, 21/
- Industry faced with financial problems - long term investments required, in some cases several times net worth of manufacturer, with no appreciable financial return for a period of five to 10 years after program commencement.
- Most manufacturing companies engaged in military procurement, thus benefiting from military effort through transfer of technology. Adjustments in military procurement can thus greatly affect development.

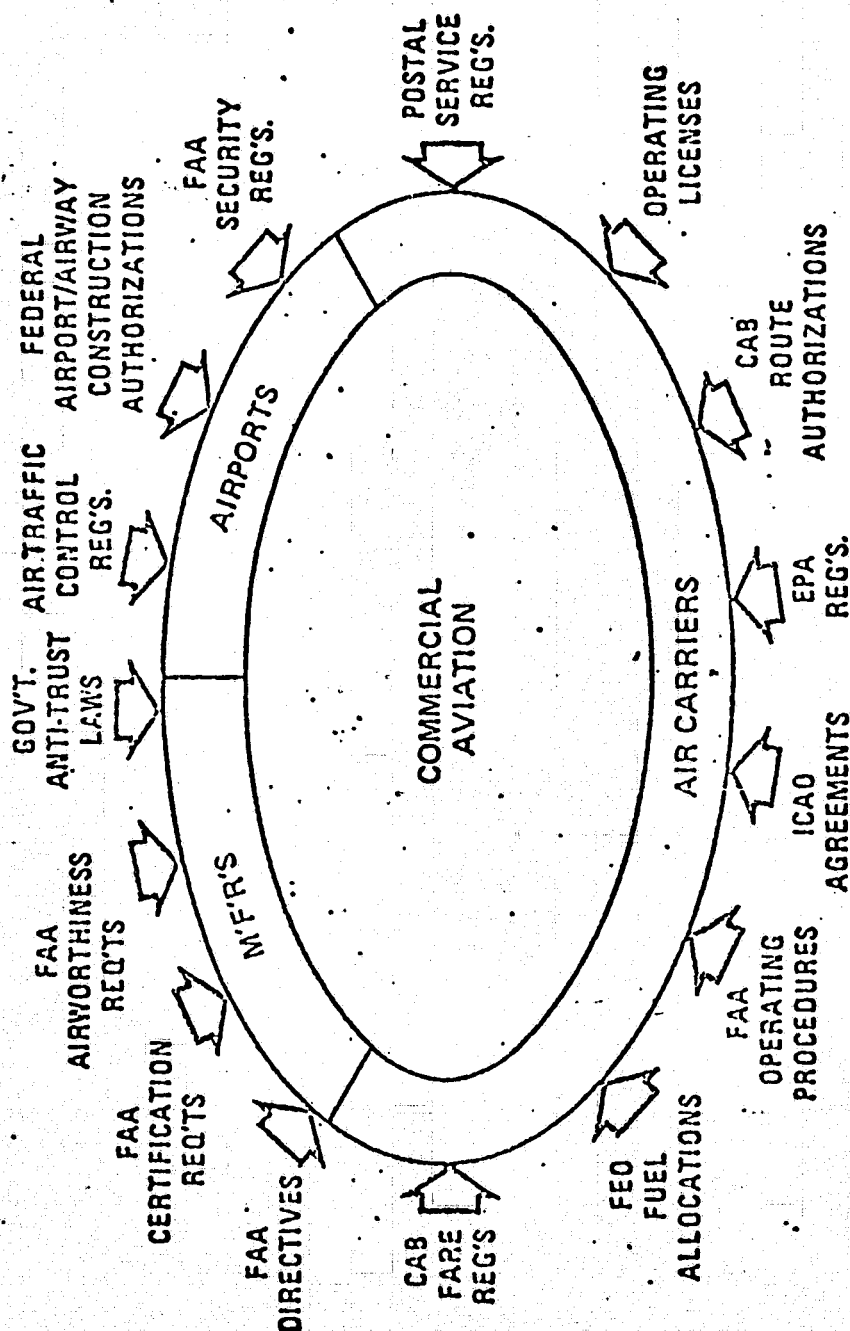
● Air Transportation

- Controlled and regulated industry - not free enterprise
- Oligopolistic structure of industry
- Government restraints in areas of safety, reliability of service, and economics
- Agencies include CAB, FAA, Postal Service, EPA, NASA, Justice, FEO as noted on next chart.

● Foreign competition increasing

- Europeans striving for deeper penetration of world market—capture 20-25 percent of aircraft sales by 1980 22/
- Other nations developing national ambitions
- Foreign Governments provide major R&D support for new foreign aircraft programs.

HEAVY GOVERNMENT INVOLVEMENT



ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

4. IMPORTANT ELEMENTS OF AVIATION INDUSTRY

- Strength relates to maintaining aeronautical superiority through—
 - Research and technology
 - Design and production in—
 - Performance, effectiveness, acquisition cost, operating efficiency, reliability and safety
 - Financing
 - Marketing strategy
 - Service.
- Research and technology is major building block in the overall well-being of the aviation industry. Thus emphasis of presentation will be directed to this element—R&T.

5. IMPORTANCE OF RESEARCH AND TECHNOLOGY AND KEY DEFINITIONS

● Research and Technology Basic to U.S. Aviation Superiority

- Government sponsorship has provided impetus for most of significant technological advances made by U.S. aviation
- Military has been first to use 75 percent of the most significant technological advances, building foundation of operational experience that led to acceptance and use in civil aircraft programs several years later
- Continued U.S. leadership in aviation requires major research effort today—leadtimes are long before use in civil aviation
- Major emphasis required in noise abatement, pollution control, congestion, energy savings, short-haul air transportation, long-haul air transportation
- Commercial transports are extremely complex vehicles that are designed to be light in weight, low in drag, and easy to manufacture and repair. Aircraft development requires a high level of technology intensity.

● Definitions

- Research (sometimes referred to as basic research): disciplines—oriented activity directed toward an increase in knowledge in the physical, biological, or social sciences
- Technology (sometimes referred to as applied research): the application of knowledge to arrive at techniques, design data, or design criteria, or to demonstrate the feasibility of a concept with no intention of going into quantity production of operational articles.
- Development: the application of technology to the design and fabrication of specific components, sub-systems, systems, or processes, and to the testing and evaluation of these articles or processes with the intention of going into production. This part of the R&D is, therefore, referred to as "prototype".

6. PRESENT ROLES OF GOVERNMENT, INDUSTRY, UNIVERSITIES IN RESEARCH AND TECHNOLOGY

• Government—

- NASA—Basic research and technology, proof of concept, data bank for collection and wide dissemination of technical information, support of other agencies due to unique facilities covering all aircraft. Develop and maintenance of unique national facilities. Major research effort in structures, propulsion, materials, aerodynamics, guidance, noise abatement. Inhouse and contractor effort.
- DOT/FAA—R, T&D for air traffic control, runway technology, navigation landing aids, communications, airports, and environment. Inhouse and contractor effort
- Military—Significant funding of research, technology, and development. Contractor and inhouse effort.

• Industry—

- R, T&D effort with financing by direct contracts from DOD, NASA, and DOT/FAA, indirect government funds in support of independent research and development or bid and proposal expense, and finally company funded projects
 - Industry funding about 25 percent of effort over years
 - Industry finances civil vehicles prototype development, some applied technology.

• Universities—

- Basic research and technology, financed largely by government contracts.
- Funding of R, T&D—
 - Government—activities which benefit both military and civil aviation, pay-off is usually unpredictable and long term and a large investment in people and facilities is required over a long period of time. This applies to research and technology especially.

7. GOVERNMENT OBJECTIVES IN AERONAUTICAL RESEARCH AND TECHNOLOGY

• National Aeronautics and Space Act of 1958—

- Preservation of the role of U.S. as a leader in aeronautical science and technology
- Most effective utilization of scientific and engineering resources of the nation
- Provide for the advancement of aeronautics as a science and the solutions of the problems of flight, including development, construction, testing, and operations for research purposes, of aeronautical vehicles.

• Presidential Aeronautics and Space Report

- 1972—Work in aeronautical research and development vital if America is to maintain its leadership in development and production of civil and military aircraft and engines
- 1973—Beginning to harvest benefits of past aeronautical research and can anticipate new operational services based on aerospace technology to be made available for public good in the years ahead.
- Aeronautics R&T is critical to the health of aviation, government should continue to provide the reservoir of technology and provide financial backing.

8. QUESTIONS RELATING TO GOVERNMENT ROLE IN RESEARCH AND TECHNOLOGY--
ALTERNATIVE APPROACHES

- Is present approach to management and funding the right way to attain R&T objectives?

Alternative Approaches to Government Role in R&T Management and Funding

- Management and Control—Public or Private
 - Quasi-Federal agency
 - COMSAT-type
 - University sponsorship
 - Industry.
- Funding
 - Government
 - Industry
 - Recoupment/User charge
 - Hybrid of above funding approaches, including joint funding of research and facilities.

9. CRITERIA AND CHARACTERISTICS FOR EVALUATING ALTERNATIVES

• Criteria

- Nature of and need for product to be provided
- Responsiveness to changing needs
- Efficiency in terms of cost
- Motivation to produce timely and best product.

• Characteristics

- Can the organization perform research and technology in terms of—
 - Responsiveness, especially in terms of crisis
 - Providing leadership
 - Shifting priority in line with changes in international situations
 - Technological inputs for regulatory function
 - Providing impartial and independent evaluation of approaches.

10. INDUSTRY ROLE IN CIVIL AERONAUTICAL R&T

- Is this an appropriate time to consider shifting toward private industry and away from Government with respect to overall direction, management, and funding of aeronautics R&T?
- Industry has performed some research and development with its own funding, but primarily in applied and prototype areas, directed toward specific aircraft systems. Most of its efforts sponsored by Government.
- Major considerations affecting industry R&T—
 - 7-15 year time lag for payback
 - Profit necessity discourages "Public Good" R&T
 - Profit emphasizes immediate application and payoff
 - Proprietary protection of costly long-term R&T
 - Antitrust constraints to consortium approach to large R&T efforts
 - Capacity to invest in large scale systems does not exist, since single failure may bankrupt a company
 - Today's cash flow problems probably necessitate application to other purposes, other than R&T
 - Technological risk of R&T investment increases as level of technological sophistication increases
 - High acquisition and operation cost of R&T facilities.
- Industry is very much involved in R&T aeronautics today with Government sponsorship. Capability exists from technical standpoint to manage R&T, but not for financing R&T at present levels.

11. GOVERNMENT ROLE IN CIVIL AERONAUTICAL R&T

1. National crises requires quick response and ability to draw on government base of scientific and engineering talent available in government R&T activities, such as energy crisis.
2. Nature of many of the R&T activities involves uncertainty as to outcome and success. Only government can afford to deal in environment with this type of risk. For example, new experimental research aircraft are far too expensive for most firms.
3. Only the government can sustain "large negative cash flows" for long lead times normally associated with even successful application of results, especially in today's climate of high interest rates and cash availability.
4. Support by foreign governments of aeronautical R&T introduces an additional risk for U.S. firms and introduces factors of international competition; balance of payments and foreign subsidies of sales, which need to be offset by U.S. government support of R&T to equalize economic disadvantage.
5. Decentralized, competitive, and uncoordinated industry program could yield patch quilt of projects responsive to individual and parochial proprietary objectives rather than national need.
6. Proprietary nature of individual research discourages joint ventures and promotes overlapping and duplication.
7. Government expertise provides evaluation of competitive proposals and accurate validation of industry products, and to serve as technical broker between industry and regulations of environment and safety.
8. In many cases, there is no private incentive to engage in R&T activities which result in significant benefits to the industry as a whole, such as wake vortex hazard alleviation and areas which could result in reduction of government costs.
9. Availability of excellent government aeronautical facilities and expertise is unsurpassed, with many of facilities unique.
10. Only the government is able to properly disseminate results in a broad and non-discriminatory manner.
11. Maintain necessary technical competence for the government, independent of industry, to provide continuity.

12. NASA ROLE IN AERONAUTICAL R&T

- Considerable precedent, legislative and operational experience - excellent team in existence and sunk costs in unique and expensive facilities.
- Commonality of research base with space, including the relationship between aircraft and shuttle.
- NASA focal point for dissemination of aeronautical data.
- Establish relationship with and understanding of industry and other government agencies.
- If aeronautical research were shifted to other agencies, the shift from NASA could result in duplication of effort and facilities, and not be cost effective.
- Ability to maintain independent non-advocacy position.
- Responsibilities under National Aeronautics and Space Act of 1958.
- Why not to military or DOT?
 - Military prime role and technical concentration must relate to mission performance and effectiveness. Some degree of risk is acceptable in applying new technology for the first time. Civil transport aircraft are designed with priority on safety, economy, long service life, and passenger comfort. Prime considerations may be quite different than those required for civil use. Divergent design requirements between military and civilian and divergence will probably increase in time.
 - DOT has regulatory responsibility through FAA. Regulatory role and advocacy role in R&T may not mix.

13. SUMMARY

- Industry Does Not Have--
 - Financial capability to assume research and technology responsibility due to--
 - Large investment which may be several times greater than net worth of manufacturer
 - Potential large negative cash flows
 - Risk with uncertainty of outcome and success in marketing
 - Profit necessity which discourages undertaking "Public Good" projects
 - Profit emphasis on immediate application and payoff.
 - Responsiveness--ability to shift priorities as rapidly as inhouse capability if national crisis occurs
 - Capability to disseminate findings on a broad and non-discriminatory basis due to possible proprietary interests in some instances
 - Ability to perform evaluation of proposals and serve as technical broker between industry and regulator of environment and safety
 - Ability to develop a coordinated and balanced aeronautical research and technology program.
- Government must thus continue to assume responsibility for management, control and funding, with some modifications in funding responsibility.
 - Government can--
 - Provide responsiveness with great risk
 - Provide financing
 - Meet foreign competition
 - Exercise a coordinated research and technology effort
 - Disseminate findings impartially
 - Provide independent evaluations

• Undertake projects for "Public Good"

- Maximize use of facilities and the strong scientific team already in existence

- Financing

- Continue efforts to increase number of jointly funded Research and technology projects

- Utilize user charge approach—i.e., at wind tunnels

- Increase cost sharing with industry and reimbursement of government costs for products used commercially.

- NASA should continue to manage, control, and finance Research and Technology for civil aviation—NASA has major role today.

As divergent design objectives between military and civil use occurs, requirements in research and technology for civil aviation may well increase. Also as program emphasis changes in military, program needs for civil aviation research and technology may increase to assure maintenance of U.S. superiority in civil aviation.

- Any major change in management approach affecting financing and timing will have massive effect on future civil aviation

- Shift in funding responsibilities can bring great economic burdens on air transportation

- No certainty that R&T funding will be provided, which could result in loss of U.S. leadership in aviation in 1980's

- Thus any change in management of funding approach should be subject of intensive study before implementation.

References

1. Joint DOT-NASA Civil Aviation Research and Development (CARD) Policy Study, DOT TST-10-4. NASA SP-265, March 1971, Washington, D. C., p.2-4 (CARD Report).
2. The Long Range Needs of Aviation, Report of the Aviation Advisory Commission, January 1973, Washington, D. C., p. 9. (AAC Report).
3. Op. cit., AAC Report, p. 9.
4. Op. cit., AAC Report, p. 9
5. Aviation Week and Space Technology, March 11, 1974, pp. 14-15.
6. Air Transport Association of America — Special date provided.
7. Aviation Week and Space Technology, March 11, 1974, p. 20.
8. Op. cit., CARD Report — Supporting Papers, p. 7-9.
9. Civil Aeronautics Board — Actual 1970 and 1973.
10. Op. cit., ACC Report, Technical Annex, Vol. I, Table A-10.
11. Op. cit., ACC Report, Technical Annex, Vol. I, Table A-11.
12. Op. cit., ACC Report, Technical Annex, Vol. I., Table A-17.
13. Op. cit., ACC Report, Technical Annex, Vol. I, Table A-18.
14. Op. cit., ACC Report, Technical Annex, Vol. I, Table A-19.
15. Op. cit., ACC Report, p. 9.
16. Lockheed Aircraft Study of Air Transportation Technology Needs, April 8, 1974.
17. Op. cit., AAC Report, p. 9.
18. Op. cit., CARD Report, — Support Papers, p. 7-9.
19. Lockheed Aircraft Study of Air Transportation Technology Needs, April 8, 1974.

20. Joint DOT-NASA Civil Aviation Research and Development (CARD) Implementation Plan, March 1973, p. 25-Tables 2.2.
21. Joint DOT-NASA Civil Aviation Research and Development (CARD) Policy Study, Institutional Factors in Civil Aviation, A.D., Little January 1971, p. 38, Table 11-3.
22. Lockheed Aircraft Study of Air Transportation Technology Needs, April 8, 1974.

APPENDIX B

**A CHRONOLOGICAL RECORD OF HISTORICAL EVENTS
(WITH A BRIEF CITATION TO IDENTIFY THE DOCUMENT)
PART A**

- 1890 Initial government support of Professor Langley's experiments with mechanical flight.
- 1903 Orville Wright successfully pilots a biplane for 120 feet in 12 seconds.
- 1905 The Wrights offer the Federal Government exclusive rights to their improved airplane and are turned down
- 1908 Wrights win a U.S. Army contract for the first military airplane.
- 1913 Charles D. Walcott, Secretary of the Smithsonian Institution makes serious attempt to revive government interest in aeronautics.
- 1915 Memorial on the need of a National Advisory Committee for Aeronautics in the U.S. transmitted to Congress by Alexander Graham Bell and Charles D. Walcott, endorsed by Franklin D. Roosevelt. NACA established by Rider to Naval Appropriations Act, March 3, 1915.
- 1917 NACA establishes the Langley Memorial Aeronautical Laboratory at Langley Field, Virginia.
- 1919 First transmittal of NACA recommendations to Congress proposing the regulation of air commerce.
- 1920 NACA proposed Bureau of Aeronautics in Commerce Department, authorizing airplane competition to stimulate new designs.

- 1921 NACA recommends Federal airways system and that Government policy be formulated to sustain and stabilize aeronautical industry.
- 1922 Federal procurement policy established that manufacturers and designers compete in design and construction of military aircraft.
- 1924 List of bills introduced in Congress from 1919 by various representatives leading to Air Commerce Act of 1926 included in a thesis written by John F. Victory.
- 1925 President's Aircraft Board (Morrow Board) recommends long-range development of Army and Navy aviation and functions of NACA be extended to cover field of advice in aeronautics invention.
- 1926 Air Commerce Act of 1926 authorizing Secretary of Commerce to regulate air commerce.
- 1929 Subcommittee formed to coordinate aerodynamic research work in universities.
- 1934 Air Mail Act of 1934 provides for establishment of the Federal Aviation Commission to report on regulation of economic phase of air transportation.
- 1935 Federal Aviation Commission's report stresses strengthening of commercial and civilian aviation and expansion of experimental work to be coordinated with NACA.
- 1938 Creation of a Special Committee on Future Research Facilities of NACA leads to recommendation of establishment of another laboratory, resulting in second NACA research station, the Ames Aeronautical Laboratory at Moffett Field.
- Civil Aeronautics Act of 1938 coordinates all nonmilitary aviation under the Civil Aeronautics Authority.
- 1939 Second creation of Special Committee on Future Research Facilities of NACA, Charles A. Lindbergh, Chairman, leads to recommendation that a powerplant research center be established at once resulting in the Aircraft Engine Research Laboratory at Cleveland, Ohio, now the Lewis Research Center.

- 1943 Secretary of Navy, Frank Knox, comments on value of NACA's World War II work.
- 1945 Dr. Vannevan Bush's statement that unless our institutions receive government support for research, the future looks dismal.
- 1946 Hearings before the Senate Committee on Interstate Commerce on a Bill to Amend the Transportation Act of 1940 so as to establish a National Air Policy Board.
- 1948 Report by the President's Finletter Commission on "Survival in the Air Age."
- Report on "National Aviation Policy" by Congressional Aviation Policy Board (Brewster Board)
- Hearings before the Senate Committee on Interstate and Foreign Commerce on "Development of Civilian Aircraft Adaptable to Auxiliary Military Service."
- 1949 Statement on "Procurement Looks at Research-Industrial Security Depends on the New-Not the Old," by George S. Brady.
- 1950 Congress authorizes construction of new NACA facilities under Unitary Wind Tunnel Plan Ad (63 Stat 936) in recognition of fact that industry could not subsidize expensive wind tunnels for research in transonic and supersonic flight.
- Prototype Aircraft Act enacted to promote the development of improved transport aircraft.
- 1952 Report of President's Airport Commission chaired by James H. Doolittle, "The Airport and Its Neighbors," calls for greater Federal and local support of required airport development.
- Dr. Jerome C. Hunsaker, Professor of Aeronautical Engineering, Massachusetts Institute of Technology, in his book entitled Aeronautics at the Mid-Century states that the U.S. aeronautical research effort from 1941-1945 was based upon a short-range policy. That 90% of the research effort was for specific development problems and 10% basic research to gain needed knowledge.
- 1955 "Forty Years of Aeronautical Research, 1915-1955," by Jerome C. Hunsaker, a Historical chronology tracing progress of aeronautical research.

- 1955 Report on "Research and Development by the Hoover Commission" makes recommendations to overcome waste and excess expenditures in Government.
- 1956 The "Federal Role in Aviation," reviewed in the 27th Intermediate Report submitted to the House Committee on Government Operations places new emphasis on research for collision avoidance systems and other air safety techniques and devices.
- 1957 Report of Edward P. Curtis, Special Assistant for Aviation Facilities Planning to President Eisenhower warning of a crisis unless airspace management system could cope with sky traffic results in the Airways Modernization Act.
- NACA authorized to undertake additional construction and install additional equipment at facilities.
- 1958 A proposal for a National Aeronautics and Space Agency drafted by the Bureau of the Budget submitted to Congress by the President.
- Select Committee on Astronautics and Space Exploration of the House of Representatives submits its report to 85th Congress, 2d session, on outer space leading toward formulation of "The National Space Program."
- The "National Aeronautics and Space Act of 1958" is created to provide for research into problems of flight within and outside the earth's atmosphere and for other purposes.
- The Federal Aviation Agency is created with passage by Congress of the Federal Aviation Act to provide for the regulation and promotion of civil aviation.
- 1959 Formation of Committee on Long-Range Studies of the potential benefits to be gained from, the opportunities for and the problems involved in the utilization of aeronautical and space activities.
- 1960 Report of the Special Investigating Committee to the House Committee on Science and Astronautics concluded that governmental assistance would be needed for the development of "Supersonic Air Transports" and recommended that the NASA assume leadership in devising an appropriate program thereof.

- 1961 In Hearings on Federal Budgeting for Research and Development before the Senate Subcommittee on Reorganization and International Organization, the question of whether or not research and development budgets are appropriate to the national needs are discussed. The effects of inflation on costs are taken into account. It is concluded that basic research receive a larger share of monies expended.
- The Committee on Science and Astronautics, House of Representatives conclude that it is necessary to inquire into the matter of aeronautical research at greater length in order to make specific recommendations for future research activity.
- The Task Force on National Aviation Goals (Project Horizon), Federal Aviation Agency, is directed to the President's report for period up to 1970 on goals providing sufficient definiteness to facilitate practicable long-range planning.
- A Study submitted to the Senate Committee on Government Operations, "Organizing for National Security," stresses the point that "the state of our military defense, our process in attaining our foreign policy objectives, the health and productivity of our economy—all depend in large measure upon making wise use of science and its application...".
- 1962 The President's Message directs the Secretary of Commerce to undertake a broad evaluation of research needs in transportation and to develop a comprehensive transportation research program for the Government.
- 1964 First progress report of the House Select Committee on Government Research on Federal Research and Development Programs identifies priorities concerning national research and development missions, policies and goals.
- "Study Number X, National Goals and Policies," report of the aforementioned Committee concludes that "Government research policies should encourage: Personal interactions with research using groups, resolution of the patent policy controversy, ... and reasonable service as consultants for applied research and using organizations."
- 1966 Policy Planning for Aeronautical Research and Development, a report prepared for the use of the Committee on Aeronautical and Space Sciences, U. S. Senate, attempts to identify those questions which are of the greatest importance for developing policy in the area of aeronautical research and development, with particular emphasis on the role of NASA in this regard.

"Federal Research and Development Program: The Decision-Making Process," 34th Report of the Research and Technical Programs Subcommittee of the House of Representatives, analyzes the Federal decision making process with respect to its \$16 billion R&D program, how fast the Government can move toward important national goals, how the nation's private sector R&D is allocated, and how the nation's supply of scientific manpower is employed.

"Department of Transportation Act" is enacted and directs the Secretary of Transportation to provide leadership in the development of national transportation policies and promote and undertake research and development relating to transportation, including noise abatement.

1967 Air Transportation and Beyond: A Systems Approach, by Bernard A. Schriever and William W. Seifert reviews some of the technological developments expected in air vehicles during the next 20 years that bear on air transportation in its social context.

A review of the adequacy of policy planning for R&D and of what the Congress, the executive branch and private industry can do to ensure that national aeronautical goals are met, especially that some development program be undertaken by NASA to reduce jet aircraft noise are set forth in Hearings before the Senate Committee on Aeronautical and Space Sciences.

1968 Report of the Committee on "Aeronautical Research and Development Policy," to the Senate Committee on Aeronautical and Space Sciences, recommends that an in-depth study should be made to analyze the relationship between benefits that accrue to the nation from aviation and the level of aeronautical R&D efforts, paying more attention to the operation of smaller aircraft and private aviation in general.

"Civil Aviation and Development: An Assessment of Federal Involvement," a three volume report of the National Academy of Engineering's Aeronautic and Space Engineering Board calls for review of air transport's part in U. S. transportation network, urging that DOT and FAA take systems approach to study of R&D goals while leaving R&D itself to enlarged NASA role.

Clifton F. Von Kann, Vice President, Operations and Engineering of the Air Transport Association of America, in a prepared statement before the Subcommittee on Advanced Research and Technology, declares that industry must look to the research scientists and engineers to tell it what technologies will be available, when and at what cost to take the lead in establishing the directions and priorities in aeronautical R&D.

1969

"Technical Information for Congress," a report to the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics. An expanded version of a background study on Congressional handling of technological matters from 1966 to 1971.

Report of the National Academy of Sciences, July 1969, to the House Committee on Science and Astronautics. The needs, problems and mechanisms for technology assessment are examined in this report by an ad hoc panel of the Committee on Science and Public Policy of the National Academy of Sciences.

Report of the Subcommittee on Science, Research and Development to the House Committee on Science and Astronautics in July 1969, prepared by the Science Research Division of the Library of Congress identifies and describes highlights of legislative and executive action that affect public policy for science and technology in the United States.

Senator Proxmire finds it shocking that the Government neither contracts for, nor directs independent research and development, especially in view of the fact that the Defense Department pays for such work, and proposes an amendment which would prohibit payment to any contractor for I.R.&D, B.&P. or QTE, unless such effort was specifically called for in the contract, or unless such work is of direct or indirect benefit to the contract work.

In Hearings before the Subcommittee on Advanced Research and Technology of the Committee on Science and Astronautics of the House of Representatives in December on "Aeronautical Research", Honorable Ken Hechler, the Chairman, discusses the problem of solving today's problems with yesterday's technologies and concludes that only advanced research can give us at least the opportunity to solve future problems with research products that are realistic and workable.

1970

Report on "Issues and Directions for Aeronautical Research and Development," to House Committee on Science and Astronautics, recommends that U. S. clarify aeronautical R&D Government industry roles, rebuild technological R&D base and use existing technology more fruitfully.

"Federal Policy on International Aviation Impact on Supplemental and Scheduled Air Carriers," prepared by Center for Political Research, June 29, 1970.

Admiral H. D. Rickover gives reasons for not favoring the establishment of a Department of Science and Technology to centralize all Federal research and development programs in a single Cabinet-level agency.

1971

There is a need for a separate research and development effort, explicitly aimed at the maintenance of technological advances in civil aircraft is the conclusion reached in "The Supersonic Transport," authored by Chatham and Huddle of the Congressional Research Service of the Library of Congress.

Aerospace Industries Association of America, Inc. recommends establishment of longer range R&D priorities and well-defined national technology strategy in its publication "National Technology Support: A Study of Research and Development Trends and Their Implications."

In "Aerospace Profits vs. Risks: An Analysis of Impact on Industry Viability," AIAA states that risks in aerospace business are very high and keep increasing and examines the relationship of risk and profit in the aerospace business.

Joint DOT-NASA Civil Aviation Research and Development Policy Study Report, March 1971 with assistance from DoD, CAB, and eight other Federal agencies was designed to explore and define the significance of civil aviation to the nation, to forecast the research effort that will be needed to enable the United States to maintain its position of leadership in aviation, and to develop alternatives for Government and industry financially of such development.

Federal Funds for Research Development and Other Scientific Activities: Fiscal Years 1970, 1971, 1972, a National Science Foundation publication (NSF 71-35) concludes that NASA has led since 1961 in basic research support, and in 1971 its share of total Federal basic research obligations was 29 percent. Declines in development obligations in 1972 are registered by NASA, AEC, and DOT.

1972

"International R&D Trends and Policies: An Analysis of Implications for the U. S.," finds that the ratio of government to private funding roughly 65 to 70 percent government during the sixties - is expected to continue, but recent policy changes indicate an upward revision of the amount of R&D performed by industry currently at the 50 percent level.

Hearings before the House Subcommittee on Aeronautics and Space Technology on "Aeronautical Research and Development," bring a favorable response from the Aerospace industries urging the prompt implementation of conclusions and recommendations made in the CARD Study.

A joint detailed study of U. S. aeronautical progress since 1925 by DoD, NASA and DOT, "R&D Contributions to Aviation Progress," finds that the future is uncertain for the high technology of aeronautics because of the reduction of new aircraft programs over the past two decades.

Report of the House Subcommittee on Aeronautics and Space Technology on "Civil Aviation Research and Development Policies, Programs and Problems," discusses the urgent need to establish long-term research goals and regulatory standards, on a specific timetable, to attain operating noise levels that will be compatible with community and local environmental objectives, and the determination of better air traffic control systems.

Supporters of Supersonic Airliners try once again to revive the Supersonic Transport at hearings by the Subcommittee on Priorities and Economy in Government.

National Science Foundation releases "An Analysis of Federal R&D Funding by Foundation," (NSF 72-313) and finds that R&D expenditures for space research still represent 18 percent of total Federal R&D expenditures in the 1973 estimate.

"The Noise Control Act of 1972" defines the purpose of this Act to establish a means for effective coordination of Federal research and activities in noise control, to authorize the establishment of Federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products.

1973 "The Long Range Needs of Aviation," are reviewed in a two year study for the President's Advisory Commission Report, January, 1973.

The Joint DOT-NASA Civil Aviation R&D Policy Implementation Plan delineates the focus and scope of the integrated detailed civilian aviation research and development activities of the two agencies.

The "State of the Aerospace Industry," and its importance in achieving the goals set forth in the National Aeronautics and Space Act of 1958 are stated in Senate Hearing before the Committee on Aeronautical and Space Sciences.

"Control of Air Pollution from Aircraft and Aircraft Engines: Emission Standards and Test Procedures for Aircraft." New standards limiting emissions from aircraft and aircraft engines are promulgated and contained in Federal Register, Vol. 38, No. 136, Part II, July 17, 1973.

Report on Aircraft - Airport Noise for the Senate Committee on Public Works prepared by the Environmental Protection Agency, Aug. 1973, served as a basis for Office of Noise Abatement and Control planned new regulations proposal of the Federal Aviation Administration and the establishment of a truly comprehensive national plan for reduction of aircraft and aviation noise.

1974

Lockheed in a publication entitled, "Air Transportation Technology Needs," concludes that the next generation long-range transport may not see service until the late 80's, in the mid-80's choice will be made as to whether this new airplane should be subsonic or supersonic and that appearance of a shorthaul transport in the late 80's appears feasible.

James C. Fletcher delivers a Speech on "Aeronautics in the American Society," at the NASA-University Conference on Aeronautics, University of Kansas, October 23, 1974. Mention is made that NASA has organized a government long-range study group "to evaluate the outlook for aeronautics in the 1980-2000 time period and the group's report should be available in the summer of 1975."

Section 231 of the Clean Air Act as amended by Public Law 91-604, June 1974, directs the Administrator of the Environmental Protection Agency to "establish standards applicable to emission of any air pollutant from any class or classes of aircraft or aircraft engines which in his judgement cause or contribute to air pollution which endangers the public health or welfare."

A guide to Federal Contract Awards and Procurement Invitations for "Noise R&D", July 1974.

"An Overview of EPA's Implementation of the Noise Control Act of 1972." ONAC has begun the work on the identification of the major sources of noise which require regulations under Section 6 of the Noise Control Act.

Dr. George M. Low, Deputy Administrator of NASA, in a letter transmitted to OM&B on Oct. 22, 1974, recommends that U.S. continue its leadership in civil and military aviation, support aeronautical R&D and T&E to relieve severe constraints found in industry and points out that NASA's role should be continued in this area because of its freedom from procurement and regulatory responsibilities in dealing with industry and other government agencies. He also discusses the benefits derived by the nation from an interrelationship of space and aeronautical R&T.